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A Study on the Synthesis of Organic/Inorganic Flame Retardant and Its Application

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2.2 Preparation of flame-retardant coating solutions

In order to perform the evaluation of flame retardancy at various mixing ratios of flame retardants, flame-retardant coating solutions containing each of TBBA/Sb_2O_3, TBBA/zinc borate, $Mg(OH)_2$/zinc borate and $Mg(OH)_2$/AF100 S/zinc borate were prepared and coated on non-flame-retardant XLPE cables.

Table 1: Composition of flame-retardant solution

Chemical	Amount (%)
Flame retardant	15-30
Binder	10-20
Dispersing agent	1.5
Leveling agent	1.8
MEK	50
Total	100

With regard to flame retardancy at various $Mg(OH)_2$/zinc borate mixing ratios, flame retardancy was not continuously increased with an increase in the content of zinc borate, but rather was reduced when the ratio of zinc borate to $Mg(OH)_2$ was greater than 0.7: 1. The reason for this is that no carbide film was formed during combustion. Specifically, it is considered that an increase in the content of the inorganic flame retardant zinc borate led instead to a decrease in adhesion, so that cracks developed between the coating layer and the substrate, and thus flame retardancy was reduced due to wide spread combustion, attributable to the supply of inflammable gas during thermal composition.

For a more excellent flame retardant effect and flexibility, the amount of flame retardant used was reduced to 1/2, and the phosphorus flame retardant AF100 S, which has an excellent flame retardant effect due to the formation of a carbide film, was added at various mixing ratios. Flame retardancy was evaluated while the ratio of

AS100 S was increased from 0.2 to 1.0 at a fixed $Mg(OH)_2$/zinc borate ratio of 1: 0.1. The evaluation results are shown in Table 6 below. As shown in Table 6, a flame retardant effect is shown when the ratio of AF100 S : $Mg(OH)_2$: zinc borate is greater than 0.6 : 1: 0.3. The test results showed that the optimal mixing ratio of $Mg(OH)_2$ /zinc borate/AF100 S was 1:0.3:0.6.

Combustion tests for non-flame-retardant XLPE cables and flame retardant-coated XLPE cables were carried out. As a result, the non-flame-retardant XLPE cables caught fire about 15-20 seconds after combustion and propagated a flame. However, the flame retardant-coated XLPE cables showed an excellent flame retardant effect, because the fire was extinguished within 3 seconds after 60 seconds of combustion.

Table 5: Effects of $Mg(OH)_2$ and zinc borate contents on flame retardancy and adhesion of flame-retardant coating solution

Run	Raw materials	UL-1581 (VW-1)	
	[$Mg(OH)_2$]/[zinc borate]	Adhesion	Flame retardancy
1	1/0.0	Good	Fail
2	0/1.0	Good	Fail
3	1/0.6	Good	Pass
4	1/0.7	Good	Pass
5	1/0.8	Bad	Fail
6	1/0.9	Bad	Fail

Table 6: Effects of AF100 S content on flame retardancy and adhesion of flame-retardant coating solution

Run	Raw materials	UL-1581 (VW-1)	
	$[Mg(OH)_2]$/[zinc borate]/[AF100 S]	Adhesion	Flame retardancy
1	1/0.3/0.2	Good	Fail
2	1/0.3/0.4	Good	Fail
3	1/0.3/0.6	Good	Pass
4	1/0.3/0.8	Good	Pass
5	1/0.3/1.0	Good	Pass